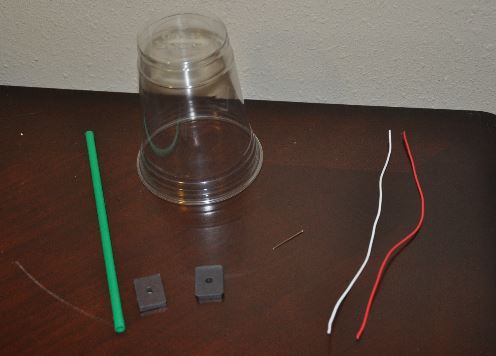
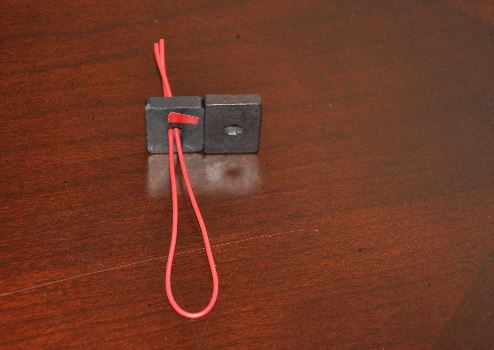
**Magnets, Electromagnets, and Neutrino Beams – LESSON PLAN**

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| **Lesson # 5** | **Practical Application: The Earth’s Magnetic Personality  (Build Your Own Straw Device)** |
| Overview  Standard(s)  & Objectives | **Overview:** In this lesson students will be given materials to build their own compass  **Standards**:  3-PS2-2: Make observations and/or measurements of an object’s motion to provide evidence for how a pattern can be used to predict future motion.  (SEP:3, DCI: PS2.A; CCC: Patterns)  3-PS2-3: Ask questions about cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. (SEP: 1; DCI: PS2.B; CCC: Cause/Effect)  4-PS3-2 Make observations to provide evidence for how energy can be transferred from place to place by sound, light, heat, and electric currents. (SEP: 3; DCI: PS3.A, PS3.B; CCC: Energy/Matter)  **Objectives:** Students will create their own straw compass to be used during this unit.  Do not refer to it as a compass until after children have built their own. See if they make their own connections. |
| Background  Information | The earth is a giant permanent magnet. This is due to its core made of mostly iron. It has a magnetic field and both a north and south pole. Compasses contain magnets that point to the earth’s magnetic poles (which are close to the geographic poles but not exactly the same thing).  The device being built today is actually a compass. When it is balanced, it should align north-south just as a compass needle would. When all groups are finished and put their devices in a similar area, they should all be pointing the same/similar direction. |
| Materials | ACTIVITY ONE:  It will be very important for students to follow the directions exactly as written to have a device that will behave correctly for future experiments. Have additional compasses premade for those who have difficulty.  For Each:   * Science Notebook * Handouts: Instructions for How to Build Your Device   For Each Pair or Small Group of 3-4:   * 2 flexible magnets (25 x 20 x 5 mm) (1 x ¾ x 2/16 inches) with a 5mm hole in middle * 1 plastic drinking straw * 2 pieces of #22 coated hook up wire, 20 cm(8 inches long), in 2 different colors * 1 straight pin, 2.5 cm (1 inch) long * 1 plastic cup * 1 piece of masking tape (to label group number and attach to cup later)and a   For groups who struggled to build compass:   * Have a few of these premade for those who could not come up with a way to balance.   ACTIVITY 2:  For every 2 students or small group of 3-4:   * Device Created in Activity 1 * Handheld Compass |
| Prior Knowledge | Magnets attract and repel.  A handheld compass points North. |
| Launch (5 minutes) | |
| Engagement and CommunicateStudent Goals and  Expectations | Refer to the Anchoring Event (Initial Video) and show the students a sample device you have created. It is helpful to do this yourself first to know which parts the children may find difficult.  State: Today you will build a device like the one used in the video we watched at the beginning of the unit. You will need to follow directions step by step to make sure each group has a standard tool of measurement.  Goal: Create a device that functions as intended in the instructions.  To do this, your group will need to:   * Designate tasks per group. (Jobs could be: Supply Manager, Reporter, Recorder, Director for following instructions *carefully*.) * Gather the necessary materials. * Use materials safely. (Rule #1 in Science: SAFETY FIRST) * Work cooperatively to create your apparatus. * Follow the instructions so each part is done correctly. * Pay close attention to the positioning of the magnets in relationship to each other. * Ensure the ends balance. Follow tips on balancing in your document. * The pin rests on top of the cup. * Be able to report to your group what you observed during your set up as later the group will report to the class. * All supplies will be returned as a device you will use later. |
| Explore (Time: 40 minutes) | |
| Procedure | * Distribute the materials to students. * Distribute the Handout with Instructions. * Tell them to pay close attention to the direction of the magnets in relation to one another. * Tell them the goal is to make sure both sides balance.   INSTRUCTIONS:  Instructions can be found on the handout with visuals at the end of this document.  (diagram may be found on pp. 32-36 of the Google book listed below)   1. Gather all your materials. 2. Put your group number on the tape and attach it to the plastic cup. 3. Bend each wire in half around your finger. The loops will later be inserted into the straw. 4. Arrange the two magnets so that they stick together side by side. 5. Push the open ends of one wire about one third of the way through the hole in the center of one magnet. 6. Repeat this procedure with the other wire and the other magnet. 7. Without disturbing the wire, pull the two magnets apart but not too far. 8. Separate the open ends of the wire and wrap each end around the long sides of the magnet. 9. Bend the loop part of the wire up over the top of the magnet. 10. Now do the same for the other magnet. 11. Double check your work. Make sure the sides of the magnets away from the loop will attract each other. When the looped ends of the magnets are pointing in opposite directions, the magnets should stick together. 12. If they repel (push away) go back to Step 5. Remove the wire from one of the magnets, turn it over and rewire it. Then go to Step 11 to check again. 13. Insert the looped ends of the magnets into the ends of the straw. 14. Balance the straw on your finger 15. Very carefully note the stop where your finger is balancing the straw. 16. Push the pin down through the straw at that balancing place so that the end just goes a tiny bit all the way through, showing 5mm of pin beneath the straw. If more than one or two holes is made in the straw, the pin will slip. 17. If you put two holes in the straw and still cannot get it to balance, try another straw. 18. Turn the plastic cup upside down. 19. Now GENTLY place the pin ON TOP OF the cup. (IMPORTANT NOTE: Do NOT NOT NOT put pin INTO the cup!) 20. Balance the straw on top of the cup. 21. To adjust the balance, push or pull the magnets a little bit at the ends of the straw as needed. Rotating or twisting slightly may help. 22. Adjust one thing at a time until a balance is reached. 23. What happens to the straw? What do you notice? 24. Record any observations you make. 25. When you are done, make sure the tape with your group number to the cup and place it in the spot your teacher designates where all devices will be on display. 26. Take good care of your device as it will be used throughout this unit. Your teacher will indicate a safe place for storage at the end of this lesson. |
| Questions | **Questions for Student Exploration:**  What name would you give your device?  **Observable:**  *In this case why was it important for everyone to follow the same directions?*  What hurdles or problems did you experience as you created your device?  What do you notice about the device you have created? (The goal is to get students to notice the straw moves)  **Unobservable:**  What forces are acting on the straw device?  What evidence do you have for that force?  **Teacher Tips:**  Create a device yourself to show the students and predict where they may have trouble.  Demonstrate the concept of balancing as it  Have a few straw devices premade for those groups who struggle.  Since children today are far more visual learners, it may be useful to show photos of step by step instructions to the whole class prior to starting.  Have extra straws on hand in case students poke more than two holes in the straw they are given.  If the straw does not move it is not balanced. Students may need to move the ends of the wire back and forth a bit to achieve the balancing act and thus promote movement.  Have a place in the room where each group may place their device at the end. In theory, all the straws should be pointing the same direction as they are supposed to act like a compass.  You will need a storage area large enough for the student compasses to be stored safely as this compass will be used again. Cereal boxes laid flat with the side panel cut as an attached lid have proven useful, as have shoe boxes.  Those groups who finish early may assist any groups who are having difficulty.  Extension: |
| Summarize (Time) | |
| Communicate | Whole Class Discussion:  After groups have discussed among themselves, call them all together for a group discussion.   * How did this process go for your group? * What parts were challenging? * What did you notice about the movement with the device?   After discussion, compare compasses via a gallery walk. The goal is for students to notice how they all point in a similar direction. If space is available, all devices may be placed in one spot, such as a back table. Pay attention to the direction of the straws on each device.   * What do you notice about the direction of the devices? * Why do you suppose all/most/many are facing the same direction? * Can you think of any other item in real life that behaves this way?   Some students may notice that their device behaves like a compass. Others may have little to no experience with compasses to make such connections. Students will have the opportunity to read a bit about earth being a giant compass. (See follow up)  Pass out the compasses to pairs/small groups. Have the students lay the compasses down flat. Now point in the direction your compass is. Why do you suppose most people are pointing in the same direction? How does that direction compare to what you saw on your gallery walk?  Hopefully students will make connections to the device they made acting as a compass. Tell them Earth is a giant magnet and that they’ll be reading more about that in the near future.    Groups need to store their compasses safely for use in the future. Get out cereal boxes or whatever storage supply being used and have students put the straw components inside. (Make sure straw is visibly marked with a group number). |
| Terminology and Concepts to Solidify | Vocabulary:   * compass-an instrument used to determine direction by means of a needle that always points north. * north pole (of a magnet)-the pole that points toward the north when magnet is freely suspended. The north pole of one magnet will attract the south pole of another magnet. Conversely, the north pole of one magnet will repel the north pole of another magnet. * North Pole—(geographical) The northernmost point of the earth. * Magnetic North Pole-- Located near but some distance away from the geographic North Pole. This is the direction in which a compass will point. * south pole (of a magnet): the pole of a magnet that points toward the south. The south pole of one magnet will attract the north pole of another magnet. It will repel the south pole of another magnet. * South Pole- (geographical) The southernmost point of the earth. * Magnetic South Pole—Located near but some distance away from the geographic South Pole. * magnetic field-space around a magnet.   Concepts:   * The earth is a giant permanent magnet with a north and south pole. * Like poles repel; opposite poles attract. * The magnetic force of a magnetic field is strongest at the poles. * The end of a freely pivoted magnet will always point in the North-South direction. (how compasses work) |
| Connection  to Big Ideas (Phenomena) | Anchoring Event  This activity is the first piece of what students witnessed in the initial video. They will be doing something similar to the video at a later date. |
| Follow Up/Practice | READING ACTIVITIES:  Read Works, Grade 4, Lexile: 820L Passage and Questions: Magnetism  <http://www.readworks.org/passages/magnetism-magnets-types-and-uses>  Read Works, Grade 5, Lexile: 1190L, Passage and Questions Set: Electric and Magnetic Forces and the Modern Day Compass  <http://www.readworks.org/passages/electric-and-magnetic-forces-and-modern-day-compass>  Why Earth is a Magnet Reading  <https://www.ck12.org/physical-science/Why-Earth-Is-a-Magnet-in-Physical-Science/lesson/Why-Earth-Is-a-Magnet/?referrer=featured_content>  Brain Pop Texts:  Flora and Fauna: This is a short text about monarch butterflies and oriental wasps using earth’s magnetic field  <https://www.brainpop.com/science/motionsforcesandtime/magnetism/fyi/>  Earth the Magnet from Explain That Stuff  <http://www.explainthatstuff.com/magnetism.html>  Read the section in the box down a ways entitled: Earth the Magnet.  Then read the rest if time allows.  How Does a Compass Work? From Live Science <http://www.livescience.com/32732-how-does-a-compass-work.html>  Brain Pop Video: The Compass  <https://www.brainpop.com/search/search.weml?keyword=compass>  Brain Pop Texts:   Flora and Fauna  Short text about monarch butterflies and oriental wasps using earth’s magnetic field  <https://www.brainpop.com/science/motionsforcesandtime/magnetism/fyi/>  Real Life Stories about why Rare Earth Magnets are no longer used in toys  (what they do to a body if more than one is swallowed)  <https://www.brainpop.com/science/motionsforcesandtime/magnetism/fyi/>  How the Aurora Works (2.23 mins.)  <https://vimeo.com/115851929>  Aurora Video Clips by Robert Schwarz  Rober Schwarz is a physicist who has participated in astronomy research for many years, spending 11 consecutive winters at the South Pole since 2001. He has a photography passion and shares the wonders of the auroras with the world here:  <https://vimeo.com/polarlights/videos>  Auroras: What Makes Them Happen—Exploratorium Site  <http://www.exploratorium.edu/learning_studio/auroras/happen.html> |
| Assessment | Students will work in groups to create a straw compass that balances. In this case the majority of time will be spent correctly making the tool to use in other investigations. A group work rubric will be used with a 3-2-1 Scale for the categories of Task Completion, Cooperative Group Work, and Communication. (3=Proficient ,2= Basic, 1=Below Basic) See Handout at end of lesson. |
|  | Adapted from Building a Compass, Magnets and Motors, from Smithsonian/The National Academies National Science Resources Center |

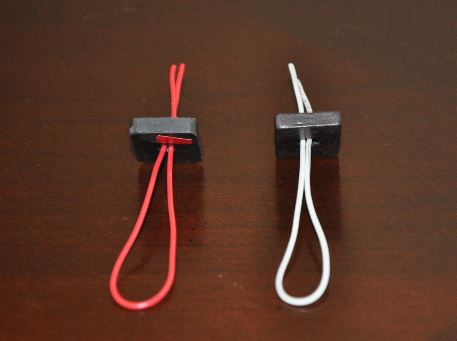
BUILD YOUR OWN DEVICE

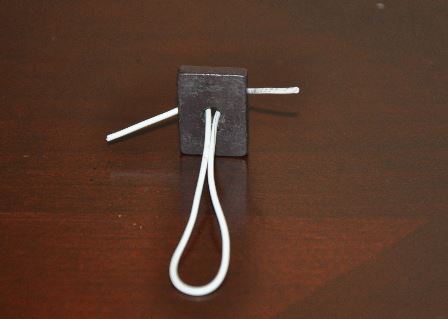


1. Gather all your materials: 1 plastic cup, 1 straw, 1 pin, 2 magnets, 2 pieces of coated wire, 1 piece of masking tape.
2. Label the masking tape with your group number and attach it to the plastic cup.
3. Next take the two pieces of different colored wire. Bend each wire in half around your finger. The loops will later be inserted into the straw.
4. Arrange the two magnets so that they stick together side by side on the smaller faces.
5. Push the open ends of one wire about one third of the way through the hole in the center of one magnet.



1. Repeat this procedure with the other wire and the other magnet.
2. Without disturbing the wire, pull the two magnets apart but not too far.



1. Separate the open ends of the wire and wrap each end around the long sides of the magnet.
2. Bend the loop part of the wire up over the top of the magnet.
3. Now do the same for the other magnet.
4. Double check your work. Make sure the sides of the magnets away from the loop will attract each other. When the looped ends of the magnets are pointing in opposite directions, the magnets should stick together.
5. If they repel (push away) go back to Step 5. Remove the wire from one of the magnets, turn it over and rewire it. Then go to Step 11 to check again.
6. Insert the looped ends of the magnets into the ends of the straw.



1. Balance the straw on your finger.
2. Very carefully note the stop where your finger is balancing the straw.
3. Push the pin down through the straw at that balancing place so that the end just goes a tiny bit all the way through, showing 5mm of pin beneath the straw. If more than one or two holes is made in the straw, the pin will slip.
4. If you put two holes in the straw and still cannot get it to balance, try another straw.
5. Turn the plastic cup upside down.
6. Now GENTLY place the pin ON TOP OF the cup. (IMPORTANT NOTE: Do NOT NOT NOT put pin INTO the cup!)
7. Balance the straw on top of the cup.
8. To adjust the balance, push or pull the magnets a little bit at the ends of the straw as needed. Rotating or twisting slightly may help.
9. Adjust one thing at a time until a balance is reached.
10. What happens to the straw? What do you notice about it?
11. Record any observations you make in your Science Notebook.
12. When you are done, make sure the tape with your group number to the cup and place it in the spot your teacher designates where all devices will be on display.
13. Take good care of your device as it will be used throughout this unit. Your teacher will indicate a safe place for storage at the end of this lesson.

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| **Group Work Rubric** | | | |
|  | **3 = Proficient** | **2 = Basic** | **1 = Below Basic** |
| **Task Completion** | Group correctly created a device that balances. | Group created a device but it had some balancing issues. | Group had great difficulty creating a proper device. |
| **Cooperative**  **Group Work** | Group worked cooperatively together to successfully complete the task | Group had some challenges working together but eventually completed the task. | Group had trouble working together as a group. |
| **Communication** | Group successfully shared thorough  observations, ideas, etc. with the class. | Group communicated  some general observations, ideas, etc. with the whole class. | Group did not meet the expectations for sharing with the whole class. |